DOCUMENT RESUME

ED 466 579 IR 021 313

AUTHOR	Chen, Wei-Fan; Dwyer, Francis M.; Chuang, Chung-Pei
TITLE	Hypermedia on Learning: A Literature Review.
PUB DATE	2001-00-00
NOTE	6p.; In: WebNet 2001: World Conference on the WWW and Internet Proceedings (Orlando, FL, October 23-27, 2001); see IR 021 310.
PUB TYPE	Information Analyses (070) -- Reports - Evaluative (142) -- Speeches/Meeting Papers (150)
EDRS PRICE	EDRS Price MF01/PC01 Plus Postage.
DESCRIPTORS	Cognitive Style; Computer Uses in Education; *Educational Research; Educational Technology; Educational Theories; *Hypermedia; *Instructional Design; Literature Reviews; Prior Learning; *Research Design; *Research Problems

ABSTRACT

This article reviews the literature of hypermedia research. Several perceived problems are identified, including: irrelevant assessment of outcome variables; weak methodological design in conducting experimental research; lack of theoretical foundations in designing hypertext systems; lack of specification of precise learning outcomes; and lack of learners' prior knowledge in the content area. Suggestions are made to reform the future hypermedia research agenda, including: future research should focus on assessing relevant student learning outcomes (knowledge acquisition, knowledge integration, and knowledge generation); researchers should develop reliable and valid instruments and methodology of experimental design (reporting reliability of criterion measures); hypermedia design should reflect hypotheses derived from established learning and instructional design theories; and future studies should consider learners' prior knowledge and varied learning styles. (Contains 23 references.) (Author/MES)

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Hypermedia on Learning: A Literature Review

Wei-Fan Chen
Instructional Systems
The Pennsylvania State University
United States
weifan@psu.edu

Francis M. Dwyer
Instructional Systems
The Pennsylvania State University
United States
fmd@psu.edu

Chung-Pei Chuang
Curriculum and Instruction
The Pennsylvania State University
United States
cic3@psu.edu

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Abstract: This article reviewed the literature from hypermedia research. Several perceived problems are identified, which include: (1) irrelevant assessment of outcome variables, (2) weak methodological design in conducting experimental research, (3) lack of theoretical foundations in designing hypertext systems, (4) lack of specification of precise learning outcomes and (5) lack of learner's prior knowledge in the content area. Furthermore, suggestions are made to reform the future hypermedia research agenda. The suggestions include: (1) future research should focus on assessing relevant student's learning outcomes (knowledge acquisition, knowledge integration and knowledge generation), (2) researchers should develop reliable and valid instruments and methodology of experimental design (reporting reliability of criterion measures), (3) hypermedia design should reflect hypotheses derived from established learning and instructional design theories, and (4) future studies should consider learner's prior knowledge and varied learning styles.

Introduction

Hypermedia learning environments are currently being employed as major components for designing and implementing educational and training learning environments. This fact can be validated by the increasing number of online courseware in school settings and corporate environments as well as by the number of articles and journals in hypertext-related literature.

Several theorists and researchers in the field of instructional technology have made strong arguments for integrating hypermedia technologies into educational and training environments. They have argued that hypertext structures match with human mind's cognitive structure, and that this congruence can facilitate learning. For examples, Kearsley (1988) has indicated that "hypertext matches human cognition; in particular, the organization of memory as a semantic network in which concepts are linked together by association" (p.23). Jonassen (1993) clarified Kearsley's statement by indicating that "hypertext provides an electronic environment to facilitate knowledge exploration via links created by the course experts. Because hypertext is a node-link system based upon semantic structures [as opposed to a sequential access system], hypermedia can map fairly directly the structure of knowledge it is presenting" (p.14). Based on these two statements, it would seem that hypermedia, properly conceptualized and implemented, would be a very effective instructional tool for facilitating

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learning.

However, in reviewing the existing research of hypermedia on learning, the results are quite disappointing (Astleitner & Leuner, 1995; Tergan, 1997). Specifically, there is little empirical evidence showing that a hypermedia learning environments improve learning outcomes (See Beeman et al., 1987; Gordon & Lewis, 1992; Hammondm & Allinson, 1989; Jonassen, 1993; Jones, 1989; Marchionini, 1990; Marchionini & Shneiderman, 1988; van Den Berg & Watt, 1991). Additionally, it is still questionable as to whether hypermedia learning environments can be designed to be effective and efficient learning environments for different kinds of learning objectives (Astleitner & Leuner, 1995; Balcytiene, 1999; Spiro & Jehng, 1990; Tergan, 1997). The purpose of this paper was to review the existing literature related to hypermedia learning environments and to point out some of the inadequacies that may be limiting its potential usefulness in facilitating student learning. As a result of this review of the literature, suggestions for future research in the field of learning with hypermedia are provided. The ultimate goal of this article was to examine the research base in hypermedia on learning in order to identify existing limitation inherent in existing research and to provide a research agenda, the results of which would assist instructional designers in producing appropriate instructional materials to facilitate student achievement of the varied levels of performance outcomes.

Problems Associated with Learning with Hypermedia

Astleitner and Leutner (1995, p.389) have identified three basic problems on learning with hypermedia. They are:

- Goal attainment: which comes from distraction caused by the huge amount of information in a hypermedia system. Under this circumstance, students will miss the most important information and spend too much time on browsing unnecessary information.
- Spatial disorientation: which comes from the complex node-link structure of hypermedia. Students do not know where they actually are, where they come from and where they should go next. This is the famous so called lost-in-hyperspace problem when they learn in a hypermedia environment.
- Knowledge acquisition: which comes from learner's cognitive overload when they confronted with a high memory demand.

While the first two problems deal with the information retrieval process, it has little to do with learning. The third problem related to human information acquisition process related to the learner's cognitive overload when they are confronted with a high memory demand guides the literature review of this article. This contention is supported by Whalley's statement, claiming that "the concerns of the developers of hypertext systems have always primarily focused on information retrieval rather than learning" (1993, p.8).

By reviewing the existing literature of hypermedia on hypermedia learning, several potential problems are summarized as follows:

- Assessment of irrelevant outcome variables: The majority of the hypertext research focuses on the navigational behaviors on information retrieval instead of evaluating learning performances as the related to different types of learning objectives (See McKnight et al., 1990; Schroeder & Grabowski, 1995; Senn & Horton, 1996; Simpson & McKnight, 1990).
- Weak methodological design in conducting experimental research: Astleitner and Leutner (1995) observed that research in the field of learning with hypermedia is still dominated by computer scientists by charging that they "do not dispose of that high-quality methodological repertoire concerning empirical investigation which is usually common to social scientists. Often studies are based on weak designs with only few persons and without experimental control" (p.395). Similarly, Tergan (1997) contends that the major problem in the hypermedia research over the past ten years was that it was too technologically oriented and not so well grounded in the knowledge of applied cognitive science.
- Lack of theoretical foundations in designing hypertext systems: Many of the current hypertext applications are designed with no instructional theoretical foundations, emphasizing technical features or simply designing by intuition (Astleitner & Leuner, 1995; Balcytiene, 1999; Spiro & Jehng,

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1990; Tergan, 1997).

- Lack of attention to learner prerequisites: Learner's prerequisites (prior knowledge, aptitude, reading comprehension, etc.) have been established to be a critical learning variable that influences hypertext learning. However, most empirical studies on learning with hypermedia do not take into account individual differences and learning styles. Researchers fail to consider that "novice learners are not typically familiar with the procedures associated with constructive self-regulative learning" (Tergan, 1997, pp. 227-228).

Future Research Agenda

In acknowledging many of the problems associated with the hypermedia research reviewed, several suggestions are made to guide future research in the field of learning with hypermedia.

- Future research should focus on assessing relevant student's learning outcomes that would include facts, concepts, abilities of comprehension, problem solving skills and other higher critical thinking skills. Student's authentic learning capabilities cannot be completely understood by simply looking at their browsing behaviors, such as numbers of mouse clicks or time spent on a single hypermedia page.
- Different types of hypermedia routines need to be examined in terms of their differential effects in facilitating achievement of different types of educational objectives.
- Hypermedia routines need to be examined in terms of their ability to create learning environments conducing to facilitating achievement in terms of knowledge acquisition, knowledge integration and knowledge generation.
- To overcome the methodological drawbacks, researchers should develop reliable and valid instruments for measuring student's performances in hypermedia learning. More importantly, the studies should be conducted in experimental settings with cognitive psychological background and also grounded in existing research base. Reliabilities of all dependent measures should be reported.
- For hypermedia courseware designers, the design should be based upon instructional theories. For examples, elaboration theory developed by Reigeluth and his associates (1978) helps select, sequence, summary and synthesize course contents, which can serve as a good design model for organizing hypermedia materials (Chou, 1999; Hoffman, 1997); cognitive flexibility theory developed by Spiro and his colleagues (Spiro et al., 1988; Spiro & Jehng, 1990) can be used as a prototype for designing complex and ill-structured knowledge domains by providing multiple perspectives, cases and examples.
- Future studies should consider learner's different learning prerequisites and learning types, for instance, various characteristics such as high/low prior content knowledge/skills, field dependence/ independence and so on. Additionally, many of the independent variables associated with the study of aptitude-treatment interactions should be taken into account in the design of hypermedia learning environments (Tergan, 1997).

Conclusion

As we continue to investigate how hypermedia learning environment may be manipulated to positively influences student's learning, it is crucial that particular attention be given to guidelines derived from instructional theory and experimental methodology as well as consideration of leaner characteristics and learning styles. Only by initiating a systematic program of investigation where independent variables are judiciously manipulated so as to determine their relative effectiveness and efficiency of facilitating specifically designated learning objectives will the true potential inherent in hypermedia be realized

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